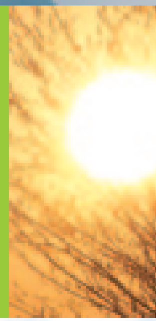
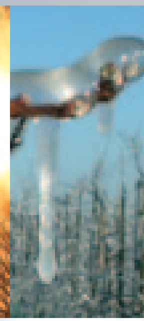
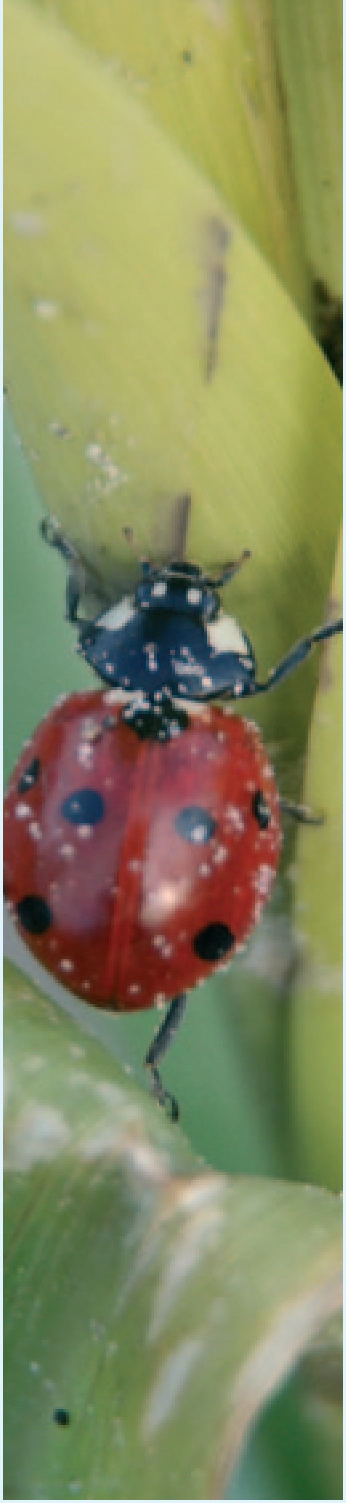
Weather & Crop Protection

Erno Bouma



Colophon

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When using crop protection products, always comply with the legislation of the country in question.

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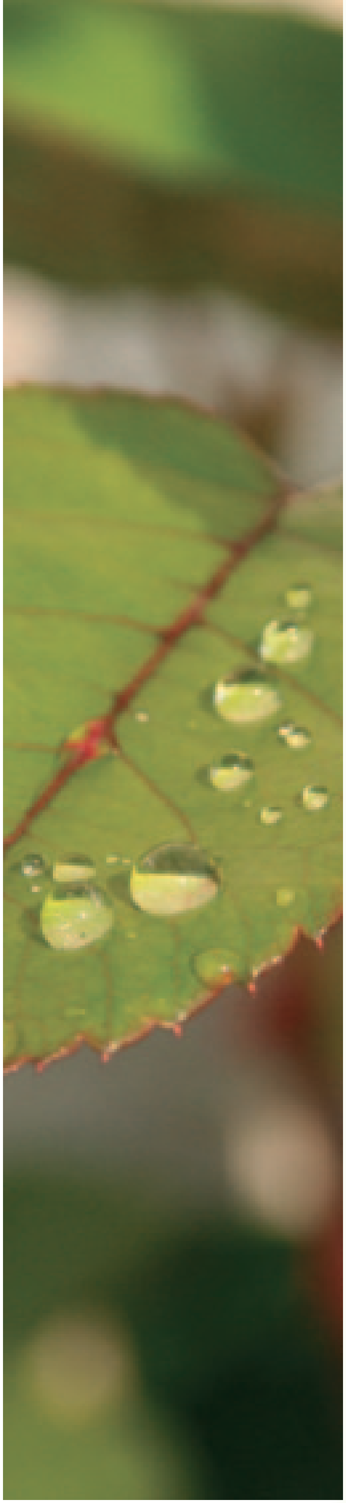
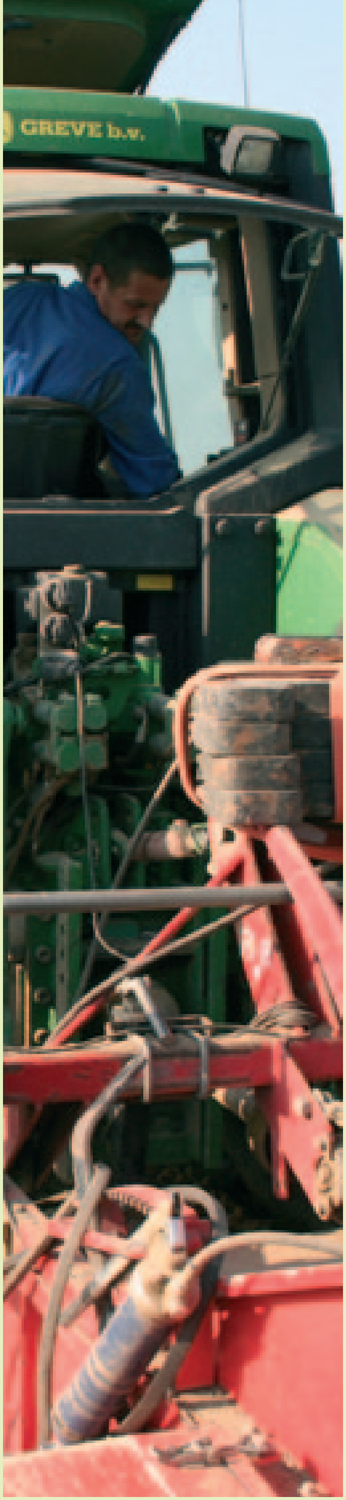
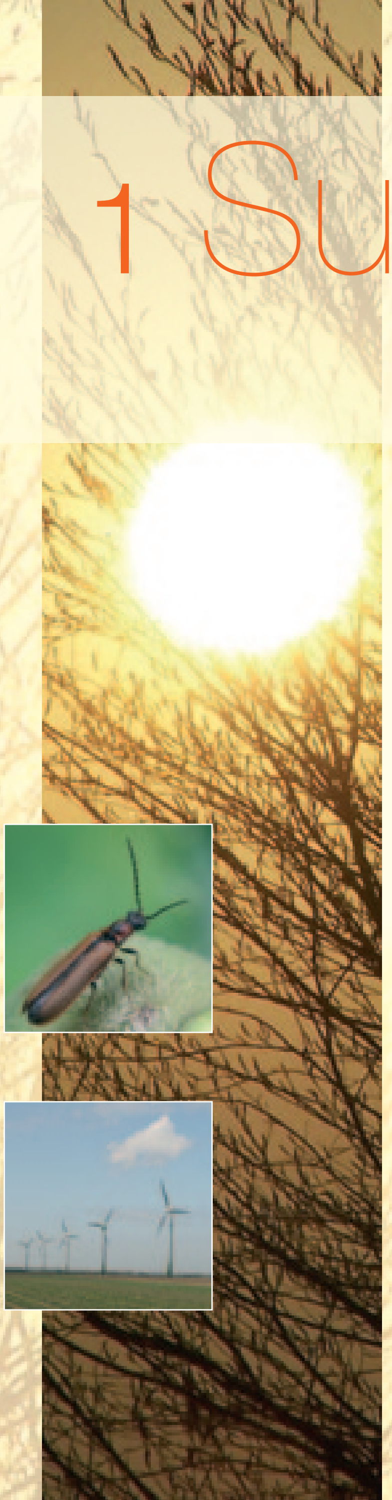


Contents


GREVE b.v.

1 Sun,
a source of heat



Sunlight provides plants with the radiation they need. Solar radiation affects crop development, the flowering process, and the shape, colour and stem elongation of plants, while temperature has a direct or indirect influence on the application and effect of crop protection products. Unfortunately, the sun is also a source of life for pathogens, fungi and insects.

Solar energy

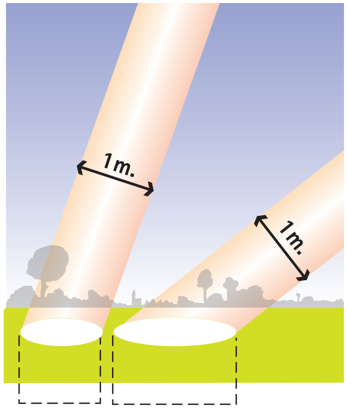
The sun emits radiation. Some of the radiation that reaches the earth is reflected back. Part of the spectrum is observable as visible light, but there are also invisible regions, i.e. ultraviolet and near-infrared. Much of the radiation emitted by the sun goes unnoticed, such as short-wave gamma radiation and X rays, or long-wave radio and television frequency radiation. This type of radiation becomes noticeable only if there is a sudden, enormous burst of it on the sun. However, much of it is blocked by the atmosphere and never reaches the earth's surface. Radio, television and mobile telephone communications are sometimes severely disrupted during these bursts of hot gases (sunspots). These extremes are of no interest to plants. Crops thrive best on UV-A, blue, red and far-red radiation, from which they derive their growing power. Solar radiation is pure energy.

Global radiation

The radiation falling on a horizontal surface is known as global radiation, which is usually expressed in Joules per square centimetre per day. On a clear, dry summer's day the maximum global radiation in north-west Europe is between 2,800 and 3,100 Joules per cm^2 over the course of a day. On a cloudy day in late December, radiation levels are frequently below 30 Joules per cm^2, only one percent of the level on a sunny summer day!
The amount of radiation is relatively high in the summer. Levels are much lower in southern countries such as Portugal and Italy than in north-west Europe, despite the sun's angle of incidence. This is because summer days are markedly longer in north-west Europe than in the Mediterranean countries. The highest total radiation (an entire day's worth of energy) around the longest day is somewhere in the north of Denmark. Even further north the days are indeed longer in summer, but the sun's angle of incidence is significantly smaller. Even a small country such as the Netherlands experiences differences in day length: the day in the north (North Groningen) is 20 minutes longer than in the south (South Limburg) in the summer (and 20 minutes shorter in the winter).

Low sun

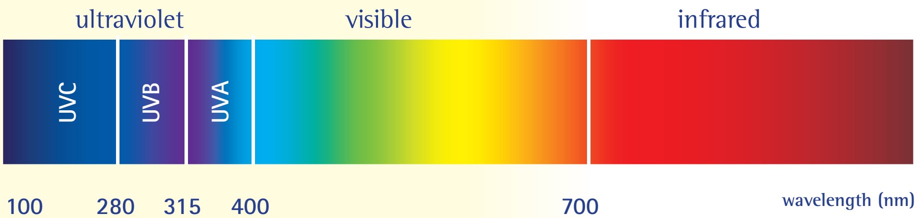
Incoming solar energy is distributed over a horizontal surface. When the sun is lower in the sky, as in winter, the energy is distributed over a larger surface area, which means much less energy per square metre.



What does the plant see?

A plant 'sees' more than a human being. Even colours outside the visible spectrum are useful to plants. Blue light (400-500 nm) and red light (600-700 nm) have an effect on the plant's photosynthesis. Radiation in this range is known as photosynthetically active radiation, or PAR. Blue light influences crop formation and red stimulates the flowering process. UV radiation (300-400 nm) affects the shape and colour of the plant, while far infrared radiation (700-800 nm) influences stem elongation and flowering.

Observable radiation is visible light. Invisible forms include ultraviolet and near-infrared. Both visible and non-visible radiation contain usable energy. Chlorophyll granules absorb mainly blue and red light.



Even if the air is not freezing 1.5 metres above the ground, the crop is at risk of freezing.

From Watts to Joules

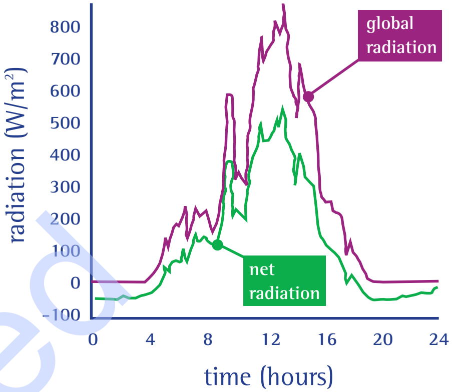
The intensity of global radiation (the solar radiation falling on a horizontal surface) is expressed in W/m^2. Adding up the global radiation over a period gives the incoming energy in that period per unit of surface area (power x time = energy). An entire day's worth of energy is the total radiation, expressed in J/cm^2.

Everything radiates heat

Every object with a temperature above absolute zero (-273°C) emits radiation. The energy emitted increases rapidly as the temperature rises. This radiation is known as heat radiation. In agriculture and horticulture, it is important to know how much energy different types of radiation supply or indeed take away from the soil and crops. The result of this process of give and take is the net radiation. If a crop gains more radiation (= energy) than it loses, it will become warmer. In this case the net radiation is positive.

Night frost

Imagine the crop temperature is precisely 0°C, on a clear, dry, still night. At 0°C the radiation emitted is 316 W/m^2. Due to water vapour and certain atmospheric gases, the leaves and plants receive only 240 W/m^2, giving a net radiation figure of -76 W/m^2. The crop loses more and more energy and cools down. As a result, the air just above the leaves and crop cools down. This means that the air temperature will rise with the distance above the crop. If this situation persists over several hours the crop temperature will fall below freezing point, resulting in a night frost.



Progression of global radiation and net radiation over the course of a summer's day. Global radiation is zero during the night due to the absence of solar radiation. As a result the net radiation at night is negative, only becoming positive once the global radiation exceeds a certain threshold. It becomes negative again a few hours before the sun goes down.

Conversion table for the different types of radiation

Conversion table for the different energy units in which radiation is represented, using artificial lighting as an example, with the energy output of lightbulbs represented in different units. PAR stands for photosynthetically active radiation.

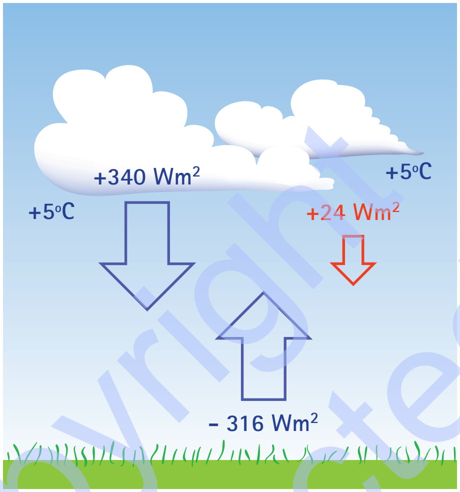
	Photons (µmol/m²/sec)	PAR (W/m²)	Energy (W/m²)	Light (lux)
Photons (µmol/m²/sec)	1	0.22	0.43	56
PAR (W/m²)	4.6	1	2	260
Energy (W/m²)	2.3	0.5	1	130
Light (lux)	18,000	4,000	8,000	1

Cloud cover: a warm duvet

During a cold night low clouds move in. At ground level, soil and plants cool down the air. Night-time temperatures are lowest at ground level. However, clouds consist of water droplets and water is a good conductor of heat so the temperature of the crop will start to rise. It is not true to say that the clouds will stop the crop from radiating. In fact, it is the other way round: the clouds act as a heater or stove over the plants.

Ice to prevent freezing

Sprinkling is the only way to prevent frost damage. This method works on the principle that heat is released when freezing occurs. This heat ensures that the ovary remains at 0°C: below that temperature fruit tree ovaries will die. As long as water runs over the ice the flower buds will remain at 0°C, even if the air temperature is much lower. If you stop sprinkling the water freezes and the temperature dips below zero, so keep sprinkling until the temperature of the ovaries rises above zero again. This stage is reached when the ice falls off. In fruit farming this method uses approximately 3-4 mm of water per hour.

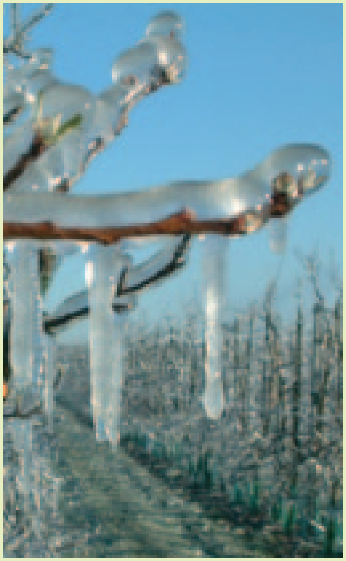


The underside of the cloud layer has a relatively high temperature of around +5°C. The crop radiates –316 W/m² at 0°C and receives +340 W/m² (because the clouds have a temperature of 5°C). The net radiation goes from strongly negative to +24 W/m². The clouds warm up the crop.

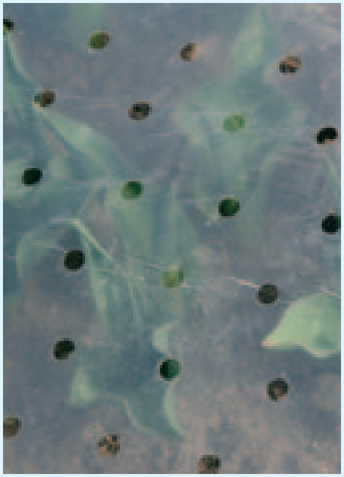
Night frost damage

Can a loss of energy be made up by burning oil in halved oil drums? Probably not, because you would have to distribute enormous quantities of energy evenly over the leaves or the crop. The amount of energy that would have to be distributed per hectare is 760 KW/ha. A modern windmill working at full capacity can compensate for the energy loss from just over 2.6 hectares. A medium-sized electricity power station can make up the loss from around 460 hectares. Another option is to hope that cloud cover moves in before it's too late.

In the area of the Netherlands known as the Veenkoloniën or Peat Colonies, mechanical weed control is always hazardous during periods with a risk of night frosts. This operation introduces additional air into the soil and disrupts the conductivity between topsoil and subsoil. Do it in the morning. This will allow the soil to settle over the course of the day and its conductivity to recover to some extent. Carrying out weed control later in the day increases the risk of damage.



Sprinkling can be used to prevent frost damage in fruit trees.



Polythene film retains heat while allowing energy from sunlight to pass through freely.

'Taking the temperature' of a plant's leaves is not straightforward. It calls for special infrared meters with a narrow sensor range. Infrared meters are used in glasshouse horticulture to check the temperature in the glasshouse for example. Their sensor range is too wide for measuring leaf temperatures.

Weather report doesn't tell the whole story

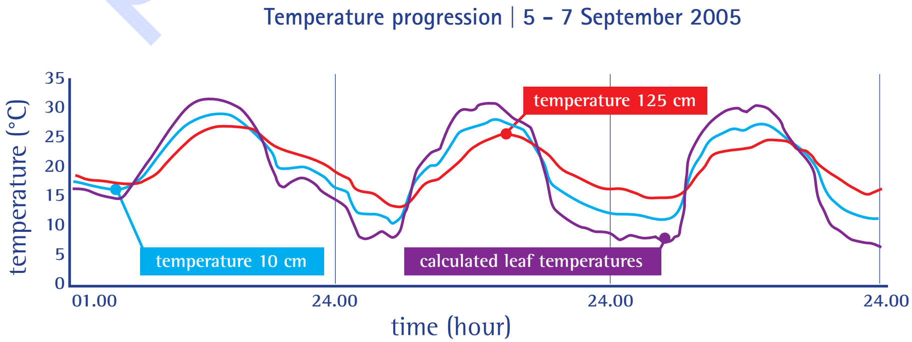
The temperature in weather reports is measured 125 cm above mown grass. However a crop grows on soil. If you look at the temperature progression at different heights (10 cm and 125 cm) on a sunny day, the temperature at ground level is lower in the morning, and higher during the course of the day, than the temperature at 125 cm. Why is this? The sun warms the plants and then the plants warm the air, not the other way round (the net radiation is positive). As a result, the surface of the soil and the crop are warmer than the surrounding air during the day. The leaves of the plants act as a heating element. The difference between the leaf temperature and the temperature at 125 cm may be as much as 10°C. At night the net radiation is negative and the leaves and surface of the soil cool the air down, with the lowest temperatures being found at ground level and close to the leaves.

Warming the soil

To take maximum advantage of sunshine that warms the soil and crop foliage (but not the air) in early spring you can use perforated polytheme film or fleece. The sun's radiation is absorbed by the soil or leaves under the layer of film or fleece. The temperature of the soil and leaves rises, and they then warm the air. These higher temperatures are retained under the film or fleece, advancing the crop.

Temperature progression

The daytime air temperature on a sunny day is higher at 10 cm than at 125 cm. The differences between crop temperature and that at a height of 125 cm are often widest during the daytime. At night, the temperature at 10 cm is lower than that at 125 cm. As a rule of thumb, the difference between the air temperatures at 125 cm (red line) and 10 cm above grass (blue line) is as great as the difference between the temperature at 10 cm and the temperature of the leaf itself (purple line).



Covering beet heaps

In the autumn, harvested sugarbeet are stored in heaps where they are at risk of freezing. The usual advice is to cover the foot of the heap if there is a risk of frost. Only if a harsh frost is expected is it necessary to cover the whole heap. This advice is not always correct.

At night objects radiate energy. The clearer the night, and the colder the surrounding air, the more radiation they emit. Sugarbeets radiate energy too. After a while their temperature falls below zero and they freeze. The beets that were slightly damaged during lifting burn their sugars (reserve food supply) a little faster than normal. This generates a considerable amount of heat, which starts to rise, hence the advice to cover only the foot of the beet heap. However, if a large amount of radiation is emitted and the beets are in the heap for several days, the heat compensation is far from enough to keep the cooling beets at the top of the heap frost-free.

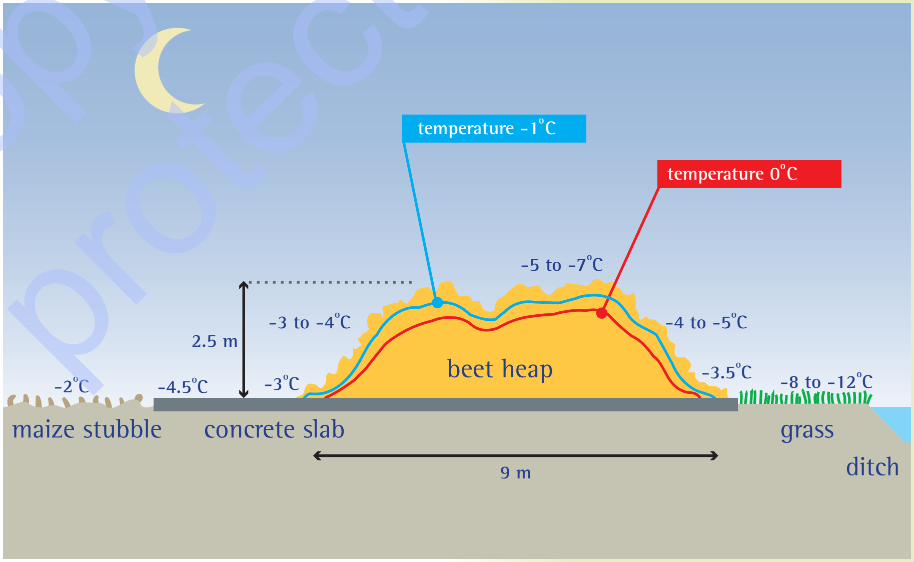
The revised advice is therefore as follows:

- With recently lifted beets, cover the foot of the heap in the event of frost.
- With recently lifted beets, cover the heap completely in the event of frost accompanied by wind.
- If beets have been in the heap for several days already, cover them completely in the event of frost.

Storing starch potatoes

Potatoes are exposed to the same risks as beet in the autumn and early winter. Insulating the heap with plastic and straw, together with the heat generated by the potatoes, is usually enough to prevent frost damage. In the case of potato heaps, also close the ventilation holes in periods of severe frost and wind.

The weather conditions dictate how a beet heap should be covered.



On bright nights harvested beet radiate a lot of energy, as do the grass, the concrete slab and the maize stubble beside the beet heap. The beet, grass and other objects cool down as a result, which is why it is important to cover them correctly. In this case the beet should be covered on top because the temperature there is much lower than the temperature at the base of the heap.

In the case of oil-based formulations the active substance is dissolved in a solvent (a). These liquids are then mixed (emulsified) to produce the spray mixture (b). The spray mixture changes from a clear liquid to an opaque, white, milky liquid (emulsion). It is in this form that the mixture is applied to the leaf cuticle (c).

Effect of temperature

Temperature is seen as vitally important in crop protection, but it is not the only significant factor. Other meteorological factors have a more important effect, such as moisture in the air, leaf wetness duration and precipitation.

Most crop protection products are intended to be absorbed above ground by the leaves or stem. However, leaves and stems are protected by a non-living leaf skin or cuticle. The crop protection product has to penetrate that barrier before it can be absorbed into the living parts of the leaf. It can then be transported, depending on its mode of action. Temperature affects many crop protection products directly:

- By accelerating or improving uptake.
- By accelerating the effect of the product itself.

Formulations

Knowledge of formulations is useful in order to understand how plants absorb products and what factors influence the rate of uptake. Formulating means combining pesticide active substances and auxiliary substances in such a way that the active substance can be distributed effectively. Auxiliary substances include solvents, carriers, emulsifiers and wetting and dispersal agents.

Active substances dissolve in oleaginous or oil-based substances (apolar formulation), or mix with or dissolve in aqueous or water-based compounds (polar formulation). Around 95 percent of formulations are water-based. Take this into account with respect to the desired rate of uptake and also consider the effect of weather factors. For example, contact herbicides such as glyphosate are not absorbed after several days of hot, dry weather.

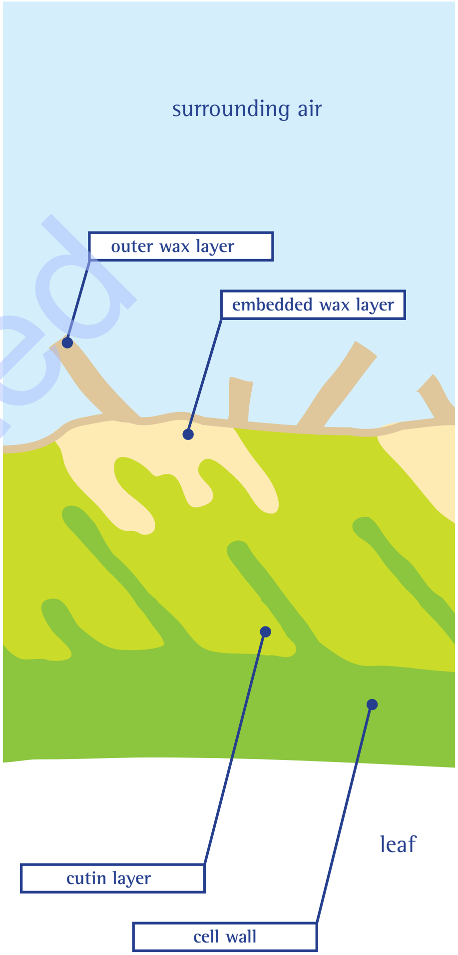


Diagram of a leaf cuticle. The wax layer protects the leaf from drying out, but also makes it difficult for crop protection products to penetrate the leaf.

Rate of uptake

In the case of oil-based formulations, temperature is the only meteorological factor that affects the rate of uptake. Oil-based formulations adhere to the wax layer very quickly. Examples include the emulsifiable concentrates (EC) and oily-flowables (Ofl). All crop protection products with these abbreviations in their trade name or on the label, such as the synthetic pyrethroids (deltamethrin, lambda-cyhalothrin and esfenvalerate), are absorbed very quickly. The higher the temperature (10-15°C), the faster the uptake.

Weakest link dictates rate of uptake

Water-based formulations are also absorbed more quickly when the weather is warmer. These formulations can be identified by the addition of the letters SL, EW, SC or WG to the product name or on the label (eg. Plenum 50 WG or Sencor WG). However relative humidity (RH), soil moisture content and solar radiation are more important than temperature for these formulations. The plant's transpiration rate must be as high as possible for the plant protection products to be transported quickly. If its roots are in soil with a low soil temperature in the spring, the plant's sap circulation will be barely ticking over. The plant may take up the water-based formulations, but it will then transport them very slowly and their effect will be only moderate.

Because plants have their roots in relatively cold soil in the spring, their sap circulation is not at its best. Plants show this by clenching their leaves, reducing their moisture loss. Make sure plants are in top condition before spraying.

Virtually all synthetic pyrethroids are available as oil-based formulations. The solvents in the formulation ensure that the active substance penetrates the wax layer quickly. When sprayed on a dry leaf, the active substance penetrates the wax layer of a tulip leaf, for example, within an hour.

Weather conditions, including the temperature of soil and leaves, play a role in determining how quickly and easily plants can absorb plant protection products.

Insecticides and temperature

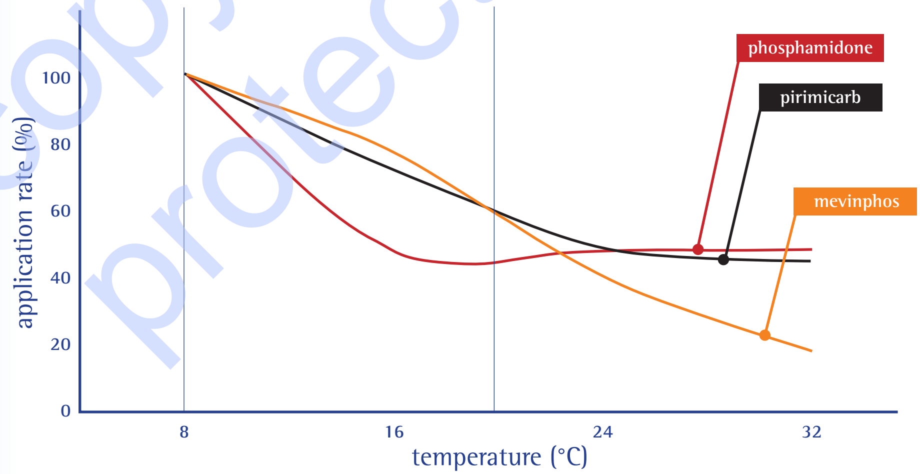
In the case of insecticides, it makes sense to take account of temperature when calculating application rates. Roughly speaking, they fall into two groups: all insecticides, apart from the synthetic pyrethroids, work better at higher temperatures (including Pirimor, Dimilin, Admire, Plenum and Vertimec). The synthetic pyrethroids, such as Decis, Sumicidin and Karate, work well at slightly lower temperatures but less well as the mercury rises.

A soil herbicide such as chlorpropham breaks down quickly in the top few centimetres of warm soil, and also evaporates quickly. In cool, dull weather its effect is prolonged, sometimes by as much as three weeks. A soil thermometer is therefore a useful aid.

Persistence and temperature

The active substances in plant protection products such as herbicides and insecticides often work better when the weather is warmer. All of the chemical processes in the plant are speeded up, including specific processes that are targeted by products such as herbicides. Herbicides that inhibit photosynthesis and respiration include phenmedipham, linuron and bentazon. Their effect is enhanced because a greater amount of light (during sunny weather, for example) results in higher temperatures in the leaf and so accelerates the specific processes that are targeted by the herbicides mentioned. If the herbicides have been applied in dull weather, weeds disappear like melting snow when the weather turns bright and warm. Herbicides from other groups also work better at higher temperatures, such as hormone herbicides (MCPA, mecoprop-P) and modern grass herbicides (such as fluazifop-P-butyl). However, their persistence is shorter. In the case of soil herbicides, a higher soil temperature combined with a good moisture content leads to the faster breakdown of the product by bacteria and fungi in the soil. Higher temperature is good for the effect of an herbicide, but not so good for its long-term persistence.

Relationship between temperature and required application rate of insecticides



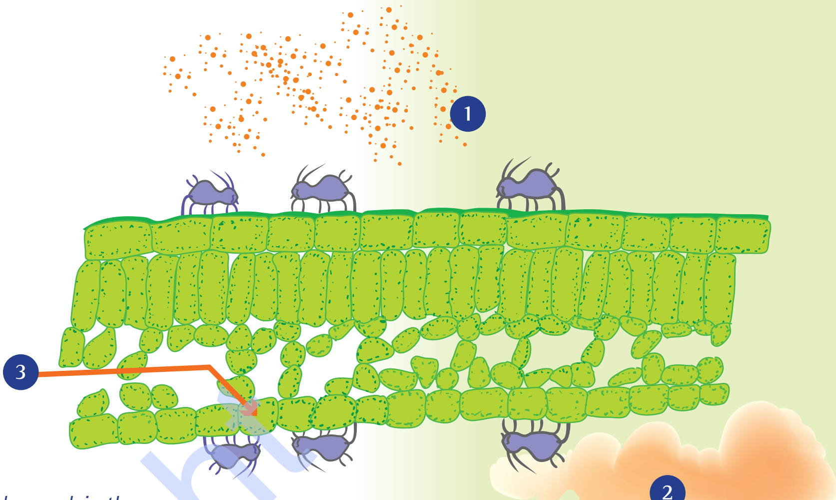
The diagram shows the relationship between temperature and required application rate of the insecticides which correlate positively with temperature, ie. all insecticides with the exception of synthetic pyrethroids. When spraying is carried out in less ideal, cool conditions (8°C) the full application rate is required. At 20°C, however, 60 percent of the full rate is sufficient. The lower application rate does not result in reduced sensitivity (resistance) of the insects to the insecticide.

Insecticides in warm weather

When is the ideal time to spray with insecticide? Insects take on the temperature of their surroundings. An aphid takes on the temperature of the leaf on which it is sitting, a leafminer larva that of the leaf in which it has taken up residence. Their activity increases with temperature. And the more active the insects, the greater the likelihood of them coming into contact with the insecticide. They also exchange more air and eat more. In addition, virtually all insecticides work better at higher temperatures (with the exception of synthetic pyrethroids). But take care! Insecticides break down quickly in strong light conditions. During warm, sunny periods they degrade extremely quickly (sometimes in as little as 12 hours). Always spray in the early evening, when the crop temperature is still fairly high but levels of sunlight can be expected to fall quickly after spraying.

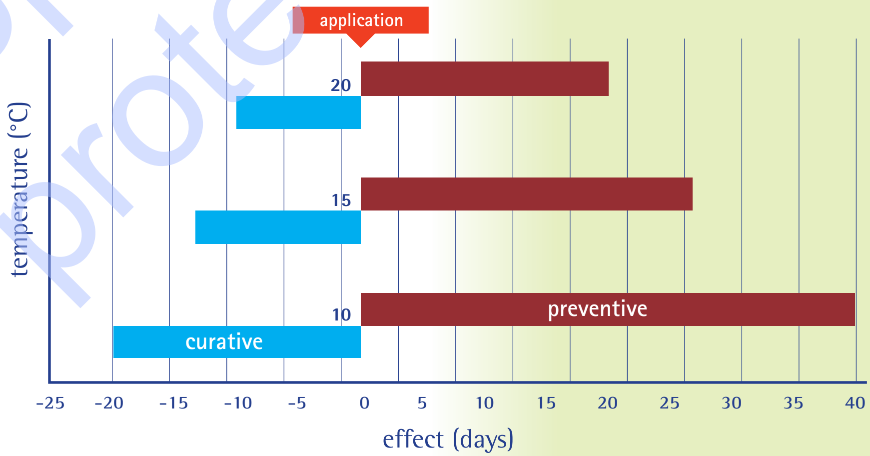
Persistence of cereal fungicides

How long cereal fungicides work against pathogens depends to a large extent on temperature. Fungicides can be subdivided into preventive and curative agents and those with both properties. Temperature dictates how fast fungal mycelium grows in a plant. Some fungi are still capable of killing mycelium tissue in the plant after 20 days if the average leaf temperature has been 10°C. If the average temperature has been 20°C, it is reduced to 10 days. At that temperature, the pathogen spreads through the plant tissue twice as fast.



Insecticides work in three ways:
1. By direct contact.
2. By 'respiration' via the trachea (respiratory orifice).
3. By ingestion via the mouthparts (eating or sucking).
Insecticides usually work via two or three of these routes.

Curative and preventive effect of fungicides in relation to temperature (eg. epoxiconazole+fenpropimorph **for the control of** *Septoria tritici***)**



Persistence of the curative (healing) and preventive (protective) effect of an agent. At low temperatures the curative and preventive effects are long-lasting. If the average daily temperature is doubled, the number of days of preventive effect is halved.

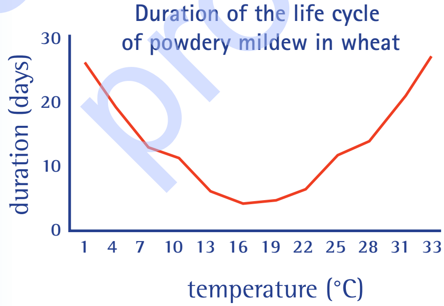
The pea leafminer takes 27 days to develop at 18°C. At 22°C the figure is reduced to 17 days.

Powdery mildew no lover of heat

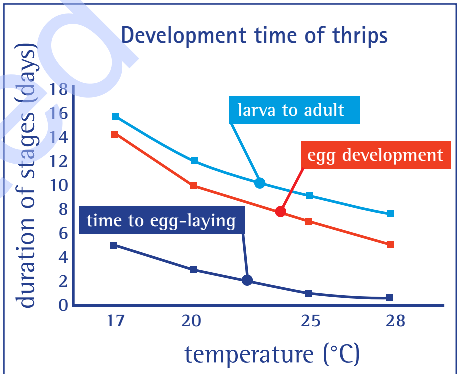
May and June are the riskiest months for powdery mildew infection in winter wheat for example and severe infection can seriously reduce yield. If the weather in May is dry and sunny, winter wheat will remain largely free of mildew. When the sum is shining brightly on the leaves, leaf temperatures are well above 20°C at that time of year, much higher than the optimum temperature for the pathogen. If the weather is cloudier and more changeable, leaf temperatures tend to be much closer to the optimum temperature of 20°C.

Insects prefer warmth

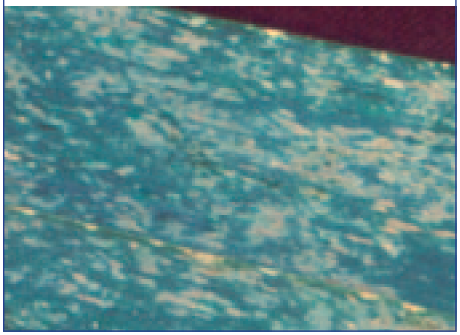
Insects too have an optimum temperature at which they develop quickest. For example, the rate of development of tobacco thrips is 44 days at 15°C, 15 days at 20°C and 15 days at 30°C. It is the leaf temperatures that are important here, not the air temperatures at 150 cm. This is also one reason why a thrips infestation in leeks on a lighter, sandy soil develops so quickly in early summer sunshine. This is when the leaf temperatures are almost identical to the optimum growth temperature of the thrips.



Fungi grow more slowly at temperatures above or below their optimum temperature. This example of powdery mildew in wheat shows that the maximum growth occurs around 20°C (leaf temperature).



The development time of thrips is strongly temperature-related. In warm, sunny spells thrips damage in leeks is virtually inevitable (see photo).



Heat soaks into the soil

Heat spreads in the soil by conduction. Imagine the soil is made up of thin layers. First of all the top layer warms up. Only once the first layer is warmer than the next can heat sink in further. But warming up the first layer takes energy, so less energy is available for the second layer than for the first. Even less energy is left over for the third layer, and so on. The deeper the layer, the less it warms up. In addition, warming the ground takes time. Later in the days the soil starts to cool down again from above. At even greater depths layers are still warming up, albeit not very much.

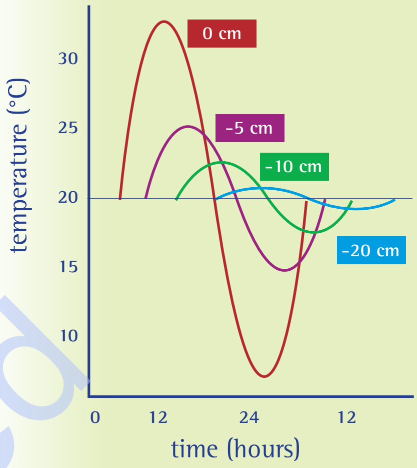
Risk of bruising

At temperatures below 8°C potato tubers become susceptible to bruising due to knocks and bumps. To reduce the risk of bruising during harvest it is important to know when to check the temperature! First thing in the morning is not a good time. Half an hour after sunrise is the coldest time of the day, above ground at least. It takes a while longer before the coldest time is reached at a depth of 10 cm, is where most potatoes are found. In addition, the time taken depends on the type of soil. On clay soils, it may be a couple of hours. The coldest time of the day is around three hours after sunrise, so wait until coffee time before going out to check the temperature!

Heat penetration

Penetration of temperature at different depths. The deeper the penetration, the less the amplitude (difference between the maximum and minimum temperature) and the later the peak and trough will occur (blue line). A sort of phase shift occurs. The temperature is more stable at greater depth, and hence lags behind, with the delay at a depth of 1 to 2 metres being around two months. If the temperature at the surface fluctuates between -2°C and 25°C, at a depth of 1 metre the corresponding fluctuation is between 7°C and 13°C. This is why deep cellars are cool in summer and warm in winter. The soil too is cold in spring but stays warm in the autumn.

Temperature progression in peat soil over 24 hours at three depths



During warm and sunny weather in June/July, tulips can die back more quickly. This brings the harvest forward by a week or two.

Air insulates

Don't loosen the soil too deeply for the seedbed in the spring. An aerated seedbed becomes warmer than a denser subsoil in the daytime, but colder at night. The subsoil under the seedbed stayes colder because it is more difficult for the heat to penetrate downwards. Is there a lot of loose soil after the winter? If so, keep your seedbed preparation to a minimum, as in the case of this frozen soil (photo).

Mulch tulips with straw

At around -4°C tulip bulbs start to freeze. The commonest method used to prevent frost penetration is mulching with straw. This means planting as early as possible and putting a winter mulch on straight away. Soil type and soil structure also influence susceptibility to frost.
In an extended period of hard frosts the ground will freeze even under a straw mulch, but the temperature of the frozen soil layer is not quite as low. Also, the frost penetrates less deeply than it would in the same soil without straw, but thawing is much slower. Frost under straw may stay in the ground longer than it would without a mulch. The straw can be removed around the first of March, provided there is no frost left in the ground at any depth. Note that straw has a temperature-reducing effect above the straw layer in the spring. This increases the risk of night frost damage, which is another reason to remove the mulch before the tulips start to poke through.

Risk of disease

Mulching bulb land does bring a major risk: the risk of disease. Tobacco necrosis as well as Fusarium can infect the bulbs more readily if there are relatively high soil temperatures in the autumn. The critical level is a soil temperature of around 10°C.

Tulip or other bulbs are best mulched just after planting. Keep the mulch on until the sun gets stronger, around the first of March.

Soil freezes

Soil freezes very slowly. This is because the freezing of moisture in the soil generates a lot of heat which first has to be conducted away. It's no wonder that frost penetration is extremely slow compared with the penetration of a temperature wave. The frost penetration index can be calculated fairly reliably using the frost index and a soil constant. The frost index is the negative total over a 24-hour period of the average surface temperatures from the moment when they become negative.

A lot of insects after a mild winter?

At the end of a mild winter it's often said that there are bound to be a lot of insects in spring and summer. Nothing could be further from the truth. Many insects overwinter in the soil as larvae or pupae. The temperatures at a depth of 2 to 3 cm in the soil rise no higher than -2°C to -4°C during a fairly harsh winter, while temperatures above ground range from -10°C to -14°C. Larvae and pupae are able to tolerate the underground temperatures in a state of winter dormancy.

In mild winters there is often a lot of moisture in the soil. Larvae and pupae in winter dormancy find moisture much more difficult to deal with. Due to the high moisture content and mild temperatures, fungi and bacteria remain active. Fungal tissue attacks and kills many pupae and larvae. This is why hard, dry winters result in a much greater insect burden in spring and summer.

Calculating the frost penetration depth

The frost penetration depth can be calculated using the following formula:

$$\text{frost penetration} = \text{soil type constant} \times \sqrt{\text{frost index}}$$

Soil type	Constant
Dry sand	**6**
Loam and light clay	4
Heavy clay	3
Peaty soil	2.5
Peat	2

Frost penetration, an example calculation

Day	24-hour surface temperature	Frost index
1	- 4.5°C	4.5
2	- 7.5°C	12
3	1.0°C	11
4	- 5.0°C	**16**

At the end of the fourth day the frost penetration on sandy building land is **6**$\sqrt{\mathbf{16}}$ cm = 24 cm, compared with 12 cm on heavy clay and 5 cm on grassland on peaty clay.

A lot to do for the ladybird in early spring (the photo shows a ladybird larva). If larvae and eggs of aphids survive the winter.

Insect larvae such as Taxus beetle larvae are not so hard hit by a dry, cold winter. Temperatures in the soil rarely fall below -4°C.

The weather has a greater influence on crop protection than many farmers think. It affects the development of diseases and pests, the application and effectiveness of products and the protection of plants and harvested crops. These relationships are explained clearly in the practical guide *Weather & Crop Protection*.

What are the ideal weather conditions for spraying? Not a gale or downpour, but certainly not a dead calm either. What demands do crop protection agents impose in terms of temperature, humidity and other meteorological factors? Insects are more active in warm weather, for example, and may pose a problem. But, at the same time, insecticides are more effective in warm weather. *Weather & Crop Protection* has the answers to these and many other questions.

After reading *Weather & Crop Protection*, anyone involved in outdoor cultivation will understand the influence of weather on diseases, pests and their control. He will be able to take preventive action or respond in good time to the first signs of disease in order to achieve the best possible results for his crop, his wallet and the environment.

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